

JOURNAL
OF THE
AMERICAN FOUNDRYMEN'S
ASSOCIATION.

VOL. 2.

APRIL, 1897.

No. 10

The American Foundrymen's Association is not responsible for any statement or opinion that may be advanced by any contributor to this Journal.

PROCEEDINGS OF THE
PHILADELPHIA FOUNDRYMEN'S ASSOCIATION.

The regular monthly meeting of the Foundrymen's Association was held in the assembly room of the Philadelphia Commercial Museum, South Fourth street, Philadelphia, on Wednesday evening, February 3.

The meeting was called to order by President P. D. Wanner, after all present had been conducted through the departments of the museum, in accordance with arrangements made prior to the meeting.

The reading of the minutes of the last meeting having been dispensed with, Secretary Evans reported for the executive committee as follows:

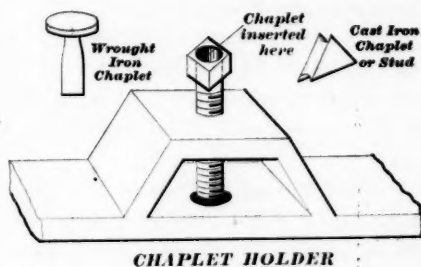
"Your committee take this opportunity to congratulate the members of this association on the permission obtained for holding their meeting at the Philadelphia Commercial Museum, where, under the guidance of Prof. Wilson, has been gathered together so many articles of commerce from different parts of the world in such a shape that they may be inspected and compared with our home product. Americans are looking forward

for a sufficient amount of foreign trade to absorb the surplus of the products of field, factory and mill, and nobody can deny that our foreign trade is increasing at a rapid rate. The reason probably is that we have built new factories and mills and expanded the old ones beyond the home demand for products, and we are therefore forced to look for other markets. The Commercial Museum is probably doing more than any other one institution toward helping us to find a foreign market, and it therefore is worthy of the support of our people. The museum authorities not only find us markets, but also ways and means for making delivery of our goods. We can therefore see what an important institution we have in our midst. As far as the home trade for products of the foundry is concerned, we realize that the iron foundry is each year being driven into a smaller corner. For instance, almost all of the cast iron trimmings that have been used in the construction of freight and passenger cars have been replaced either by pressed steel, malleable iron or cast steel, because those articles have been reduced in price to such an extent, and with them the weight, that the iron casting has been driven out of the market entirely. The same cause holds good in a number of other cases, and in the aggregate the market for iron castings is much reduced. We do not claim that the foundry business has improved of late, but we think there is a better feeling existing, and we believe that after the change in the administration and the advance of warm weather there must be a change for the better. Prices are exceedingly low and money is hard to collect. We do not look for an immediate betterment, but we think it will come slowly and surely."

No report from the price committee was forthcoming.

The secretary exhibited a new chaplet holder which he said had been sent by Joseph Hennesey, with the Wm. H. Page Boiler Co., Norwich, Conn. Mr. Hennesey, in a short paper, thus described his invention: "The device is very simple. Instead of sharpening 12 or more chaplets that require to be at least 5 inches to 6 inches long, my chaplet holder calls for a chaplet only 1½ inches, with a blunt end. The device may be adjusted to fit al-

most any size of drag, the long side resting on the bottom board. My holder with a $\frac{1}{4}$ inch chaplet will hold a core that weighs 2,000 pounds. After the pattern is drawn out the chaplets can be set in the holder in less than two minutes. The old style chaplet had to be 5 inches to 6 inches long, and had to be ground to a point, or drawn to a point at the forge. Now the chaplets come from the maker of the right length, and they are cheaper. There is no give to the chaplet after the core is set, so there is less danger of a chaplet leaking. The triangular chaplet can be used whenever you can gate a mold, and have the iron strike the chaplet when it first goes in, so that the sharp edges will welt. When the cast iron chaplet can be used it is set on top of the bolt, and there is no danger of failure. I use the cast chaplet in steam boilers that have to stand 200 pounds pressure. I would prefer a wrought



chaplet in all cases, but for work that does not have to stand any pressure the cast chaplet is all right."

The chaplet holder was handed round and thought to be a good invention for standard work, but hardly adapted for special work.

A letter from Thos. Devlin, a member of the association, was read, in which he suggested as a good topic for discussion before the association the excessive freight charges on coal to Philadelphia, which he stated were about as high as to New York, and in proportion to distance about four times as high as to Chicago. He also spoke of the need of a mutual fire insurance association for foundry and machine shops only. The stock companies, he intimated, had run up the premiums for insurance upon this class

of risk, and foundries were now paying, as he believed, excessive premiums. The communication was, on motion, referred to the next meeting.

Guy R. Johnson, general manager of the Embreville estate, Embreville, Tenn., then read a paper, entitled

"CHEMICAL HINTS TO FOUNDRYMEN."

A year ago, at the Pittsburg meeting of the American Institute of Mining Engineers, the writer had the pleasure of listening to a discussion on the physics of cast iron.

The following paper is a direct sequence, and will, it is trusted, throw some additional light on the question of the relation of the chemistry of cast iron to the physics thereof, the idea being to help out the foundrymen who cannot afford the services of a chemist, and to place before them in a succinct shape the results of over 300 physical tests and over 1,000 analyses.

The value of the subjoined notes is necessarily weakened in some degree by the fact that only one iron—viz., Embreville—has been experimented on, and that, further, a year is a short time in which to obtain a great deal of information on so vexed a subject.

Per contra, it must be said that the ores at Embreville give almost any range of any element found in cast iron, and that being worked entirely by chemical analysis, as the furnace at Embreville is, there is an almost infinite variety of demands as to chemical analysis.

Further, the writer has had much valuable information from various customers, and has been especially fortunate in having the services of so capable a chemist and well informed man as George F. Eldridge, who has had charge, under the writer's supervision, of the experiments from which the following results are deduced.

For the sake of better understanding it will, perhaps, be better to take up the elements and their effects on iron seriatim, beginning with carbon, which, the writer does not hesitate to say, has more influence on the physical characteristics of cast iron than any other, for to a large extent, as indicated below, and within

certain limits, the influence of the various other elements is exerted, not on the iron itself, but on the carbons.

Chemists tell us that there are four forms of carbon present in cast iron, but only the two best known forms—i. e., graphite carbon and combined carbon—will be considered here. In the total carbons in the same iron there is not a great variation, but the results of the relative amounts of the two on the strength and appearance of the same are enormous. The higher the carbon the weaker the iron, and it is this fact that makes charcoal iron so strong. The following are average analyses of a well-known charcoal iron and an Embreville iron of the same chemical composition except as to carbon:

	Charcoal Per cent.	Embreville Per cent.
Silicon	1.69	1.11
Sulphur	0.060	0.083
Phosphorus	0.364	0.303
Manganese	0.50	0.50
Combined carbon	0.89	0.75
Graphitic carbon	2.32	3.02
	Pounds.	Pounds.
Tensile strength	35,000	30,300

It will be noticed that the silicon is about $\frac{1}{2}$ per cent lower in Embreville iron. To neutralize this and obtain the same tensile strength the phosphorus must be lowered, and accordingly we find:

	Embreville Per cent.
Silicon	1.55
Sulphur	0.068
Phosphorus	0.185
Manganese	0.50
Graphitic carbon	2.94
Combined carbon	0.83
	Pounds
Tensile strength	28,300

The following analyses show in a general way the difference in grades and carbons:

	Graphitic Carbon. Per cent.	Combined Carbon. Per cent.
No. 1	3.80	0.10
No. 2	3.78	0.25
No. 3	3.60	0.39
Gray forge	3.00	0.70
Mottled	1.50	1.70
White	0.10	3.10

Graphitic carbon renders an iron soft, easily machined and less apt to be brittle; but, owing to its disturbing continuity, decreases tensile strength.

Its disturbing continuity arises from the fact that it is simply an inter-molecular mixture, and not, as is the case with combined carbon, a true chemical combination.

From the above it follows that an iron high in combined carbon will be machined with more difficulty, will have greater strength, but will be more brittle. To cite familiar cases:

A locomotive cylinder has to resist great wear, must be of great tensile strength and density, and yet be capable of being machined properly. As we might expect, an iron having a No. 3 or gray forge fracture is employed in the best practice. For ordinary castings, however, a much softer iron is preferable, and accordingly we find Nos. 1 and 2 being used in such work, and being mixed, of course, with other grades and scrap as suits the idea of the foundryman.

It is not difficult to transform graphitic carbon into combined carbon. Chilling has this effect, and the remelting in the foundry, combined with the chilling of the sand mold, generally produces the desired grain; while by using metal chills and sufficiently low silicon contents all of the graphitic carbon will be changed to combined carbon, giving a white iron. Sufficient repetition of remelting, with the consequent loss of silicon, will make a perfectly gray iron white. In malleable work an air fur-

nace is used to produce this effect on the first melt, though in this class of work the process is carried further and more of the carbon is burned off.

Silicon.—The effect of this element on cast iron is probably better known than any other occurring therein. Its proportion varies all the way from a small fraction of 1 per cent, as in white and basic open hearth irons, to 17 per cent or over in ferrosilicons. Its influence on foundry irons is that of a softener—i. e., it tends to turn the carbon in the iron into the graphitic state. Just what its influence per se on iron is it is impossible to say, owing to its great power over carbon, from which it is impossible to disassociate it. It is probable that its effect is to weaken, but with the ordinary run of carbons up to $1\frac{1}{2}$ per cent seems to make little difference, although it will be observed that the strongest iron in the tables is the lowest in silicon. It will also be noticed that the sulphur is comparatively high, quite enough to transform much graphitic carbon into combined.

Sulphur.—This element turns graphitic carbon into the combined state, and hence makes cast iron harder, denser and more liable to crack. The hotter the iron the lower the sulphur, and hence the graphitic carbon. From this it follows that Nos. 1 and 2 foundry have little sulphur, and it is a fact that they frequently contain less than 0.01 per cent, while a No. 3 or gray forge from the same furnace will frequently run well up toward 0.1 per cent, and white iron with over 0.3 per cent is not unusual. Such iron is usually as brittle as glass. Owing, however, to the above mentioned characteristic, that sulphur has a tendency to convert graphitic carbon into combined carbon, it is valuable in certain classes of foundry work, and an iron to show great strength and density should contain from 0.05 to 0.075 per cent or even higher, this being a point which can only be obtained by careful experiments on the iron being used. For instance, referring to table No. 4, it will be seen that 0.141 sulphur gives the highest as to tensile strength, while the iron resulting is "close gray." The outer skin of this specimen was hard to machine, although after this was turned off the iron cut more like steel than cast iron.

Another case in point is Finnspong gun iron, analyses of which show from 0.09 to 0.150 per cent. For ordinary castings, however, it is best to have the sulphur as low as possible.

It should not be forgotten in this connection that coke contains a relatively large amount of sulphur, that iron readily takes it up, and that, consequently, many a ton of castings is spoiled through neglect to have the sulphur contents of the coke analyzed either by the user or by the manufacturer. For the same reason, much pig iron is annually condemned where the fault lies with the coke with which it is smelted in the cupola. When it is remembered that the best coke made in America contains about 0.5 per cent of sulphur, and that most of it carries upward of 1 per cent, and when it is further recollected that 0.1 per cent in the castings will generally make them too hard, it will be seen that the importance of coke analysis can hardly be overestimated.

Phosphorus.—According to Vosmaer, phosphorus has a tendency to convert graphitic carbon into the combined state, but owing to the greater effect of silicon and sulphur its influence is not so marked. Its value to the foundryman lies in that it promotes fluidity and helps to overcome shrinkage.

For this reason light thin castings should be made of high phosphorus iron—i. e., 1 to 1.25 per cent, or even higher—while strong castings should not contain over 0.5 to 0.6 per cent, and chilled car wheels not over 0.3 to 0.4 per cent. Iron containing less than 0.2 per cent is apt to shrink badly and to be red short; it is, however, especially suitable for malleable work and for mixing in the foundry with higher phosphorus irons to obtain a strong mixture.

Manganese.—Like sulphur, manganese has a strong tendency to convert graphitic carbon, and is therefore a hardener; but as most irons have not a great deal of this element in their composition, generally less than 1 per cent, not much attention has been paid to it, not as much as there should be, for owing to its affinity for sulphur it serves in melting in the cupola to carry off much of this element, which would otherwise combine with the iron, and it is well known to some foundrymen that in a cupola iron

loses its manganese by combination with sulphur, the sulphite passing off in the slag.

Its presence is desirable in iron for making chilled castings, up to 1 per cent, and possibly a little beyond, but high manganese is not liked in ordinary foundry work, because castings containing much of it are sure to be brittle or even white. An illustration of this hardening effect was recently had at the Embreville Furnace.

A customer desiring a malleable iron containing over 2 per cent of manganese, it was accordingly made, but while the iron was by fracture all No. 1 and No. 2, with silicon contents from 1.50 to 1 per cent, yet the chilled pieces, cast for the laboratory, were so hard, unless special attention was paid to cooling them slowly, that they could not be drilled.

ANALYSIS OF IRON.

	Per cent.
Silicon	1.50
Sulphur	0.012
Phosphorus	0.177
Manganese	2.57
Fracture	No. 1

Of course Harfield's manganese steel is familiar to every engineer.

To sum up.—If ordinary soft—i. e., gray—castings are wanted use graphite iron, low in sulphur and manganese, but reasonably high, say 0.75 to 1 per cent, in phosphorus.

* If a strong machinery casting is wanted use an iron of close No. 3 to gray forge fracture, silicon from 0.80 to 1.50 per cent, sulphur from 0.03 to 0.05 per cent, phosphorus from 0.35 to 0.50 per cent.

For hydraulic cylinders, etc., use the same composition as above, but let the sulphur run from 0.075 to 0.110 per cent.

For chilled wheels the iron should analyze about as follows: Silicon 0.5 to 0.8 per cent, sulphur 0.02 to 0.04 per cent, phosphorus 0.20 to 0.40 per cent, manganese 1 per cent, fracture preferably No. 3 or close No. 2.

In this connection, it ought to be stated that while silicon seems to be the governing element in chill iron, at the same time phosphorus has its effect, as before noted, in changing graphitic carbon to combined carbon.

The difference, however, between the chill fracture of a low phosphorus iron and that of the same silicon high phosphorus iron is quite striking. In the low phosphorus iron the white or chilled part extends down into the gray portions of the castings like fingers, while in the high phosphorus iron the line between the chilled and gray parts is markedly straight. It is this interlacing that renders the low phosphorus iron so much more valuable for making car wheels, chilled rolls, etc.

One word ere the close of this paper on the subject of test bars. The controversy over the shape, size and results given of test bars has ranged for the past few years throughout the land.

If the views of the writer are correct, it would seem to indicate that the advocate for each size is correct, or incorrect, in direct proportion as the size of his test bar approximates that of the castings, especially in regard to thickness.

By many the $\frac{1}{2}$ -inch bar is condemned as giving too high results. This arises simply from the fact that, being small, the iron is quickly chilled, and the casting contains much combined carbon, thereby promoting its density and tensile strength. If, therefore, castings $\frac{1}{2}$ -inch thick are to be made, by all means use the $\frac{1}{2}$ -inch bar; preference in all cases being given to round bars as most apt to give regular results, owing to synchronous cooling, which cannot be present when there are four corners, at which the cooling must necessarily start.

The writer feels inclined to insist on the foundryman's requiring—when buying iron—analysis as well as fracture, for the simple reason that no man can tell anything about the composition of an iron by looking at it. As fine looking No. 1 as has ever been produced has proven on analysis to contain less than 1 per cent silicon, while irons that were apparently close grained mill irons with less than 1 per cent of silicon will contain over 3 per cent.

In such cases sulphur is apt to be the element causing the closeness of the grain, and 0.04 to 0.05 per cent of this element will produce this effect. A usual effect of this element is found in a deeply pitted face.

Either of the two types of iron just mentioned will make, if melted alone, close castings, hard to machine but taking a capital finish, while the tensile strength of both will be low.

In short, the conclusion irresistibly forced upon the writer by the results given is that, to paraphrase an old story, there is no bad iron, but some iron is better than others.

Every iron has its use, and if our foundrymen will make up their minds to buy on analysis as well as fracture, and will further watch their coke with more care, there will be fewer losses and far more regular results.

(The author concluded his paper with numerous tables of tests made upon Embreville iron. Anyone wishing to obtain these should make application to Guy R. Johnson, Manager, Embreville estate, Embreville, Tenn.)

Discussion on the paper was deferred.

Secretary Evans: "We have a treat before us to-night in an address by Prof. Wilson, who has so kindly entertained us here to-night, on the objects of this institution. I have much pleasure in introducing Prof. Wilson, and we will now proceed to the bureau of the museum, where preparation has been made for our visit."

The assembly then proceeded to the bureau, where Dr. Wilson made a lengthy address.

He said: "The idea of this institution is to develop a Bureau of Commerce. There are various institutions of the kind in Europe which have sprung up within the last 18 or 20 years, in Brussels, Berlin, Paris, Vienna and other cities, and one or two in Japan—the latter perhaps coming nearer to our idea than any of the others, the Japs being quicker to push an enterprise of this kind than any other nation. The raw products seen here are simply an attempt and a beginning to bring together here the raw

products of other countries, and by the aid of a scientific bureau we hope that many raw products not now available, and perhaps not discovered may be introduced to the notice of manufacturers. This institution began its work in 1893 at the close of the Chicago exhibition, and we are indebted to that exhibition for a great many of our exhibits. Since that time we have been working with great vigor in Mexico, South America and Europe. The institution was organized with a governing board which includes a number of prominent Philadelphians. The board is absolutely non-partisan in every way and has nothing to do with politics. The object of the institution is solely to increase trade, and especially foreign trade. It has been the idea of our promoters to form a general bureau of information, not only for Philadelphia, but for the whole of the United States; therefore in the earlier stages advisory boards were organized, which now number over 120 Chambers of Commerce throughout the United States, and these have representation on our board. That was in order that we might touch every interest in the country. Finding we must seek information very exhaustively in foreign countries and go minutely into the details we early began to introduce ourselves in the same way to all foreign Chambers of Commerce. We are at present connected with about 40 foreign chambers. Caracas in Venezuela has the first representation on the advisory board, their president and secretary being elected as members. The other chambers were admitted in the same way. Materials were sent to us in large quantities with specific data covering the wholesale prices, discounts, and every condition of the trade, and all questions have been worked up by experts. We have been furnished with complete lists of the business houses in the cities of different countries, and they are here on our files for your inspection at any time. As an illustration, we could give you the names of all who handle hardware in Caracas, Venezuela. In the United States we have about 250 representatives on the advisory board. We have special agents in different sections of Europe, notably England, Germany and France, and we have been able to obtain the catalogues of the various manufacturing

concerns of England, with their list prices and discounts, covering all the material coming to this and going to other countries. You can see at once the advantage of that. We have in a room adjoining this over 800 catalogues of recent date touching hardware, iron and all the industries of England. We are also in possession of more than a thousand catalogues from Germany and France, collected in the same way. This is one of the first methods of our work, and they are all so arranged and indexed that we can turn to any particular line of trade with ease. Through a variety of sources we have been able to obtain nearly all the government publications of the different countries, and these cover surveys, geological surveys, statistical reports concerning trade, and other matters of value. We get the trade publications of all foreign countries just as we get our own, published in every language. We have also all our consular reports and have a staff of 12 to 15 people who are reading them and placing them on our card files, and we thus make our own consular service of value, which hitherto was not made of value. As an illustration, a recent report from the consul of a foreign government came into our hands, concerning the railroads and the use of iron and steel in Japan, and containing many illustrations and photographs. We immediately took account of the information in the report and sent it to people in this country interested in railway material. This is only an illustration of what we are doing in all lines of industry. We have recently asked the governments of the different countries where we are represented to send us all invitations issued for tenders for contracts for railroads, bridges, buildings, and we have received many satisfactory answers and already received notices of tenders required in Australia, Venezuela and Costa Rica. I give you these illustrations to let you see how we are branching out in the direction of a bureau of commerce national in character. We have systematized matters so that we can serve the business interests inside as well as outside of the city."

Continuing the professor described the sources of funds for carrying on the work, and urged all his hearers to use their influ-

ence with state and national legislators towards obtaining grants towards the maintenance and extension of the institution.

Mr. Green, who has charge of the bureau, then practically demonstrated the system of compiling and disseminating information, his illustration having a bearing upon the iron trade in all its branches. There were no charges made for information imparted other than for such clerical work as was necessitated, he explained, and all seeking foreign trade are invited to make use of the institution.

PROCEEDINGS OF THE WESTERN FOUNDRYMEN'S ASSOCIATION.

The regular monthly meeting of the Western Foundrymen's Association was held Wednesday evening, March 17, 1897, at the Great Northern Hotel, Chicago, the President, Mr. A. W. McArthur, in the chair.

The following report was received from the Committee on Apprentices:

In considering the suggested amendment relative to the propriety of providing some special inducement for young men having graduated from a manual training school to take up the trade of iron molding and founding, we believe the desired end can be best accomplished by making a separate indenture for this class, believing such graduates will make the most desirable mechanics, and that their preparatory training will have given them such knowledge of the business that it will not take them as long to learn as the boy with only a common school education. We would, therefore, advise a shorter term for these young men in each class, with a modification of the duties. We would also advise a more liberal compensation as an extra inducement. We do this on account of the fact that young men having passed through manual training schools are better developed, and, of course, have greater earning capacities, than those entering the trade who are for years their juniors. This fact, coupled with their better training and higher education, make them entitled to higher compensation.

We submit for your consideration the following indenture to provide for this class of applicants:

INDENTURE FOR MANUAL TRAINING SCHOOL GRADUATES.

This agreement entered into this day of, 189..., between, a firm or corporation organized under the laws of the State of, party of the first part, and a Manual Training School graduate, party of the second part.

Witnesseth: That the said party of the first part agrees to take said, party of the second part, into its employ and service for the period of three (3) years from the date hereof for the purpose of learning the trade of iron molder, as carried on in its works, and that the said party of the second part shall truly and faithfully work and serve for said period in such capacities as the foreman may from time to time direct, and that he shall obey all rules and regulations of the works, and the party of the second part also agrees to abstain from the use of intoxicating liquors during the term of apprenticeship. The duties of the apprentice are defined as follows, but may be deviated from so long as it does not impair the apprentice's opportunity to learn the trade thoroughly: First three months to be spent at taking care and charging of cupola, also lining ladles; next six months in core room; the last three months of first year to be spent at bench molding.

The second year is to be devoted entirely to molding, the apprentice to be advanced from the small and plainer work to the more difficult and larger as fast as his capabilities will prove it is profitable to do so.

The third year is to be devoted to the most responsible work in the shop, either in dry or green sand, as the capabilities of the apprentice may justify, and should he desire to learn loam molding, it will be necessary for him to devote one further year to this special branch of the trade.

Compensation shall be as follows: First year, \$6 per week; second year, \$7 per week; third year, \$8 per week, and where fourth year is taken up, \$10 per week.

We do not consider that a bonus for extra efficiency will do any good in this class, as the incentive that impels young men in this class to take up this line of work will be all the encouragement necessary, and for the same reason we do not consider it necessary to retain any portion of the wages.

Your committee also, acting on the suggestion contained in Mr. Gates' letter, would earnestly advise the appointment of a standing committee by your association, whose duty shall consist in visiting such manual training schools as are within its

jurisdiction for the purpose of conferring with the faculty relative to the best methods of training boys to become interested in foundry work, and also to see that their equipment is adequate to assist in accomplishing the desired end, and for a mutual exchange of ideas and suggestions; said committee to report at each meeting of the association.

Referring to regular indentures in class No. 1, in defining the duties in the fourth year, your committee would now ask to have that changed so as to read, "the full year to be spent on the best class of work in the shop," etc. Also, in the first year, so as to read, "nine months of the first year to be spent in core room, etc., and three months at cupola and lining ladles."

Terms in class No. 2 for manual training school graduates, we would advise as follows: First three months to be spent in taking care of patterns and to be generally handy; next three months at care and management of cupola and lining ladles; two years following at molding in all its details from the simplest to the most difficult work, and the apprentice to be advanced as rapidly as he proves himself competent. Compensation for the first six months to be \$1 per day, and \$1 per week increase for each year, for balance of apprenticeship, where day work is the rule, and where piece work prevails the same terms as in regular indenture.

While not wishing to discourage manual training school graduates who wish to take up work in class No. 3, we cannot imagine a case where a young man with such schooling would select this branch, but to provide for such we believe the present indenture entirely suitable and can suggest no changes. We would, however, strongly recommend that the requirements as to fitness of apprentice recommended in regular indenture shall also apply to these special apprentices.

WILLIAM FERGUSON,
G. H. CARVER,
A. M. THOMPSON.

Upon motion, duly seconded, the report was accepted and the committee discharged.

Upon motion, duly seconded, a committee of three, consisting of James Frake, H. W. Carter and William Ferguson, was appointed by the chair to revise the various reports of the Committee on Apprentices and to present to the association a final report, giving accurately the legal form of indenture, which it would be advisable to adopt in each class.

The following paper on

**"PHOSPHOR BRONZE, ITS MANUFACTURE, PROPERTIES
AND FOUNDRY TREATMENT."**

By Max H. Wickhorst, was read:

Bronze is an alloy of copper and tin. Phosphor bronze is bronze containing varying amounts of phosphorus from a few hundredths of 1 per cent to 1 or 2 per cent. Copper is a soft ductile metal. Tin is also a soft metal. But by adding a little tin to copper we harden it. By increasing the amount of tin we make the alloy still harder. When about one part of tin has been added to two parts of copper, we have an alloy that is very hard and brittle. When more tin is added the metal begins to soften again.

Bronze containing simply copper and tin is very liable to be defective from the presence of oxygen, sulphur or occluded gases. Oxygen causes the metal to be spongy and weak. Sulphur causes porosity. Occluded gases cause porosity. Oxygen gets into the metal by absorption from the air. It can be eliminated by adding to the metal something which combines with the oxygen and then fluxes off. Such deoxidizers are zinc, antimony, aluminum, manganese, silicon and phosphorus. Sulphur and occluded gases can be eliminated by melting the metal, exposing it to the air and letting it thus absorb some oxygen which then burns the sulphur and gas. The oxygen can then be removed by adding one of the above mentioned deoxidizers. The important use of phosphorus in bronze is therefore to remove oxygen and also indirectly to destroy occluded gas and sulphur.

At the C., B. & Q. R. R. brass foundry at Aurora, Ill., we make a bronze with an extra high percentage of phosphorus, namely 6 per cent. We make this alloy so as to have phosphorus in con-

venient form for use, and the process of manufacture followed by us is as follows:

Ninety pounds of copper are melted under charcoal in a No. 70 crucible, which holds about 200 pounds of metal when full; 11 pounds of tin are added, and the metal is allowed to become hot. The crucible is then removed from the furnace, set upon the floor, and 7 pounds of phosphorus are introduced. The method of adding the phosphorus is as follows: A 3-gallon stone jar, half full of dilute solution of blue vitrol is weighed. Then the weights are increased seven pounds, and phosphorus in sticks about four inches long is added till the scales balance again. The phosphorus is left in this solution half an hour or longer. By this means the phosphorus is given a coating of copper, so that it may be dried and exposed to the air without igniting. We have ready a pan (Fig. 1) about 30 inches square and 6 inches deep, containing about two inches of water. Over the water is a wire netting which is laid loose on ledges or supports along the inner sides of the pan. On the netting is blotting paper, and on this the phosphorus is laid when taken out of the blue vitrol solution. The phosphorus is put on the blotting paper to dry. The pan also has a lid which can be put down in case of ignition of the phosphorus.

We now have the phosphorus ready for introduction into the metal. This is done by means of a cup-shaped instrument called a retort, or phosphorizer. Its shape is shown in Fig. 2.

Having the molten metal ready on the ground, one man holds the retort on the rim of the crucible in a horizontal position, as shown in Fig. B. A second man takes about three pieces of phosphorus and throws them into the retort. The first man then immediately plunges the mouth of the retort below the surface of the metal before the phosphorus has a chance to fall or flow out. Of course, the phosphorus immediately melts and also begins to volatilize. As the phosphorus comes in contact with the metal it combines with it. This process is continued till all the seven pounds of phosphorus has been put into the metal. The metal is then poured into slabs about 3x4x1 inches thick. The metal is

so hard that greater thickness would make it difficult to break it up. When finished, the metal contains, by analysis, 6 per cent of phosphorus. When we wish ordinarily to add phosphorus to metal we do it by adding a little of this hardener.

I will now discuss the properties of copper and the various bronzes. Copper is a soft, ductile metal with its melting point at about 2,000 degrees F., or 1,100 degrees C. Molten copper

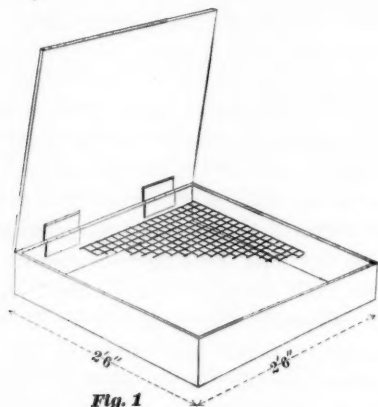


Fig. 1

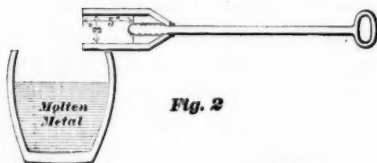


Fig. 2

has the marked property of absorbing various gases. It is for this reason that it is so difficult to make sound castings of clear copper. Molten copper combines readily with the oxygen of the air, forming oxide of copper, which dissolves in the copper and mixes homogeneously with it. This explains why melted copper has a clean surface, free from all scum; that is, as the air acts upon the copper, the oxide formed dissolves in the rest of the metal, leaving the surface clean. A casting made from such

metal would be very spongy. The bad effect of oxygen is intended to be overcome by adding zinc to the extent of 1 per cent or more. This result can be much more effectively attained by the use of aluminum, manganese or phosphorus. The action of these substances is to combine with the oxygen, and as the product formed separates and goes to the surface, the metal is left in a sound condition. Aluminum and manganese deoxidize copper and bronze very effectively, and the oxide formed goes to the surface as a scum. When a casting is made from such metal, the oxide or scum, instead of freeing itself from the casting perfectly, generally remains in the top part of the casting mixed with the metal, as a fractured surface will show. Phosphorus deoxidizes copper and the oxide formed leaves the metal in the form of a gas or white smoke; and a casting made from such metal shows a clean fracture throughout, although the metal is not as dense as when aluminum or manganese is used.

Copper also has the property of absorbing or occluding coal gas or carbon monoxide. But the coal gas thus absorbed is in a different condition from the oxygen absorbed. When oxygen is absorbed by copper the oxygen combines chemically with the copper and loses its own identity as a gas and actually forms part of the solid. But when coal gas is absorbed by the copper, it keeps its own physical identity and simply exists in the copper in a state of solution. Just, for instance, as air and other gases dissolve in water. All natural waters, such as lake water, river water, spring water, etc., contain air in solution or occlusion. When such water is cooled and frozen, just at the time of changing from the liquid to the solid state, the dissolved gas separates and forms air bubbles, which remain entangled in the ice. And coal gas which is dissolved or occluded in copper acts in exactly the same way. Suppose we cast some copper or bronze containing coal gas dissolved in it. While the metal is in the molten condition it is perfectly quiet, since the gas has no tendency to come out. We pour the metal into a mold of sand. The metal flows in all right. About two minutes or so after the metal has been all poured we notice that the gate begins to rise. This is because, just as the metal is setting the gas separates itself and assumes

the gaseous form. Therefore, as this gas takes up more room it forces the metal out through the gate. After such a casting has been allowed to cool and all the sand has been cleaned off, the surface of the casting will be free from all signs of holes in the metal. But if we take a cold chisel and chip into the top side of the casting, or have the top skin machined off, the casting will be found to be full of gas holes, and in fact, in a bad case the metal will be almost a sponge in appearance. The point I wish to emphasize is that one cannot tell whether a casting is porous by looking at the outside, since the gas which causes the porosity is evolved only after the skin has set, and therefore as the evolving gas rises to the surface of the casting it can get to the skin, but not farther.

Hydrogen acts in exactly the same manner as coal gas. Sulphur also has a bad effect on copper and bronze in a similar manner to coal gas and hydrogen. Sulphur combines with copper and other metals, forming sulphide of copper, etc. When molten copper or bronze containing sulphur comes in contact with air it absorbs some oxygen and this in turn combines with the sulphur present, forming sulphur dioxide, which is a gas which remains occluded in the metal exactly the same as coal gas does and is liberated when the metal sets, also in the same way. If the metal is allowed to absorb more oxygen, the sulphur is oxidized to a higher oxide, which does not remain in the metal but goes off in fumes.

Tin is a soft white metal, melting at 440 degrees F., or 230 degrees C. Toward gases it acts something like copper, but not in so marked a degree. Although copper and tin are both soft, yet when mixed they make a harder metal. This is because copper and tin combine with each other chemically to form a hard and very brittle substance. About two parts by weight of copper combine with one part of tin so that both substances are neutralized, and there exists no free copper and no free tin, but the mixture consists entirely of the copper tin compound. Both the copper and tin have lost their own identity and no longer exist as such, but are chemically combined to form a compound which is very hard, brittle and gray in color. If more copper or tin is

used than this, the two metals still form a chemical compound mixed with the excess of copper or tin, as the case may be. In bronze we have a copper tin compound, mixed with excess of copper, but we have no free tin. When bronze cools from the molten state, the copper and the copper-tin compound tend to crystallize by themselves. The quicker the cooling occurs, the less separation will there be, and also the fracture will be more homogeneous in appearance.

When bronze contains occluded gas, it is probably the free copper entirely which occludes the gas. I judge this from the fact that in the fractured surface of some bronze defective from such gas, the gas cavities are mostly bright yellow in color, while the gray spots are compact.

Gun bronze contains copper and tin in the proportion of 9 to 10 parts of copper to 1 of tin. This is the metal used where an ordinary bronze casting is wanted. A harder bronze is copper and tin in the ratio of 6 to 1. This is often used as a bearing metal. When either of these metals is to be turned in the machine shop, they would contain about 3 per cent. of lead, which will make them work very much better, but it also decreases their tensile strength. Bearing metal now generally contains about 10 per cent. of lead, with copper and tin in varying ratios. The large percentage of lead is put in that the metal may wear away slower. Lead, although a metal having properties similar to tin, acts entirely different toward copper. Copper and tin have a good deal of affinity for each other, but copper and lead show no attraction at all for each other. Copper and tin mix in all proportions, but copper and lead mix only to a very limited extent. About 3 per cent. of lead can be mixed with copper. With bronze 15 to 20 per cent. of lead can be mixed. In bearing bronze, the lead keeps its own physical properties, so that the constituent lead melts long before the metal attains a red heat. It sometimes happens when a bearing runs warm, that the lead actually sweats out and forms pimples on the metal. Or sometimes in remelting a bearing bronze casting the lead may be seen to drop out while the metal is warming up.

All of the metals, however, should contain something to flux or deoxidize them, such as zinc, manganese, aluminum, silicon, antimony or phosphorus.

I will describe the method of preparing phosphor bronze bearing metal in vogue at Aurora. The metal made has the following composition:

Copper	79.7	per cent.
Tin	10.	"
Lead	10.	"
Phosphorus	0.3	"
<hr/>		
100.0		

Melt 140 pounds of copper in a No. 70 pot, covering with charcoal. When copper is all melted add $17\frac{1}{2}$ pounds of tin and $17\frac{1}{2}$ pounds of lead and allow metal to become sufficiently warm, but not any hotter than is needed. Then add 10 pounds of "hardener" (made as previously described) and stir well. Remove from furnace, skim off the charcoal, cool the metal with gates to as low a temperature as is consistent with getting a good casting, stir well again and pour. We face our molds for this kind of work with plumbago.

When good copper is used this procedure will always give a good sound bearing metal. However, as some kinds of copper on the market are very liable to contain sulphur or occluded gas, this kind of copper should be melted without covering, then exposed to the air to allow it to absorb oxygen, and thus oxidize out the sulphur and gas, stirring it well several times. Then add lead and tin, remove from the furnace, add "hardener" and stir well. The idea is to allow the metal to absorb some oxygen, which removes the sulphur and occluded gas, and then to remove the excess of oxygen by adding phosphorus. As we buy copper on chemical specifications which insure good copper, I have had very little experience with poor copper.

There are several firms that make phosphor bronze bearings with a composition similar to the above one, and most of them, or perhaps all, make it by melting the metals and then charging

with phosphorus to the extent of 0.7 to 1.0 per cent. But I have found some metal from all brands that I have tried that contains occluded gas. So that after such metal is cast, in about two minutes or so the metal will be found to be porous. But I have not yet had one such experience with metal made as I have described above. My explanation of metal made by adding phosphorus direct to the final mixture containing occluded gas would be this: The phosphorus, as it is charged into the metal still contains a little moisture, and at the high temperature of the molten metal, the phosphorus takes the oxygen from this water, leaving the hydrogen to be absorbed by the metal. Whether this theory is correct or not, I cannot say from any experiments I have made. I merely offer it as a suggestion.

But this practical point should be heeded, viz.: That pig phosphor bronze should be bought to the specifications, that the metal should have shrunk in the ingot mold in cooling, as shown by the concave surface of the upper side, and that it should make a casting in a sand mold without rising in the gate after being poured.

In bearing metal, occluded gas is very objectionable because the gas in trying to free itself shoves the very hard copper-tin compound (which has a low melting point and remains liquid after the copper has begun to set) into spots, and thus causes hard spots in the metal.

Phosphorus is very dangerous stuff to handle and there is great risk from fire with it, so that many would not care to handle the phosphorus itself. But phosphor copper containing 5 per cent. of phosphorus, and phosphor tin containing 2 to 7 per cent. of phosphorus and several other such alloys can be obtained in the market. And I would suggest to those who wish to make phosphor bronze, but do not want to handle phosphorus itself, to make it by using the proper amount of one of these high phosphorus alloys. In using phosphorus it is only necessary to use enough to thoroughly deoxidize the metal, say 0.3 per cent. More than this will make the metal harder but not any sounder.

During the reading of the above paper, Mr. Wickhorst submitted the following specifications for ingot copper used by the Chicago, Burlington & Quincy Railroad Co.

First.—Copper will be bought in ingots. Each ingot must have the brand of the maker cast upon it

Second.—Each ingot must show shrinkage in the mold in cooling, as shown by the concave surface of the open side.

Third.—An analysis of the borings of an ingot, taken at random from a shipment, will be taken to represent the shipment, and must show the following chemical composition:

Copper not less than 99.65 per cent., and must be free from sulphur.

Fourth.—A shipment failing any of these requirements will be rejected.

DISCUSSION.

Mr. Sweeney: How much phosphorus is lost in remelting?

Mr. Wickhorst: There is very little phosphorus lost if the metal is well covered with charcoal.

Mr. Sorge: What is the effect of phosphorus on bronze in regard to shrinkage?

Mr. Wickhorst: Phosphor bronze shrinks very little. The reason for that is this: Phosphorus combines with the air and forms a gas. When the metal is poured into the mold, of course there is more or less drawn off and forms the gas, and you have a metal that is not very dense and does not shrink very much. If you substitute aluminum it would combine with the oxygen and would form a scum and the metal would shrink very much more.

Mr. Carter: I would like to ask how high a percentage of copper you have been able to use in any metal and still have a hard casting?

Mr. Wickhorst: I have several times made castings of copper that contained only a very little phosphorus and they were perfectly sound.

Mr. Carter: What percentage would that show?

Mr. Wickhorst: Say you had your copper 100 per cent.—to begin with you would have 99.5 per cent. copper.

Mr. Carter: Is there any difficulty in making that kind of casting?

Mr. Wickhorst: I have not made many, but with those I have made I have had no difficulty.

Mr. Carter: Do you make your copper with the hardener, such as you speak of?

Mr. Wickhorst: Yes, with the phosphor copper.

Mr. Carter: There has been a demand for pure copper castings in electrical work and there is one firm that is making quite a claim on what they call a pure copper casting. I have been casting in sections and the fracture does not seem to show any porosity at all.

Mr. Wickhorst: They do try to get that with silicon copper. I have never tried that at all.

Mr. Sweeney: How does the slight percentage of phosphorus affect copper as to its electrical properties?

Mr. Wickhorst: I do not know.

Mr. Ferguson: Does the porosity you speak of occur more readily in the heavier than the light castings? Some twenty-five years ago I had something to do with brass, I remember I had a large valve to make—250 pounds, and in portions it would run to 2 inches in thickness. We used our ordinary mixture of brass that we used for bearings and boxes. The casting came out sound, but when we cut off the face it was nothing but a mass of porosity. I reasoned at that time that it was because of its being cast in green sand, so we remelted it and cast it over again in dry sand, but with the same result. I added more tin to the mixture and the casting came out as sound as a bell.

Mr. Wickhorst: Larger castings would show the porosity more because it takes them longer to cool and any gas that does come off has a better chance to show itself. The higher the percentage of tin is, the less tendency there would be to create gas. You can take this bronze with its occluded gas and by letting it absorb air it presses the gas out; then add phosphorus and you can get a good sound casting.

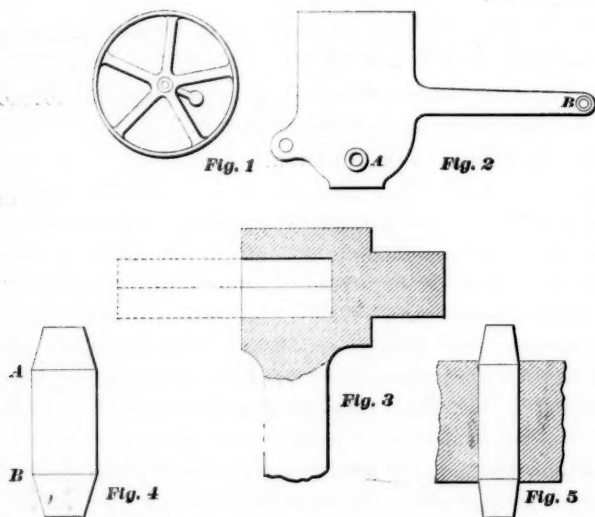
Mr. Sweeney: I would like to call attention to the fact that this paper emphasizes the value of chemistry in the foundry. The matter has been so largely discussed here that I do not think that we should let an opportunity slip to show the proof of the arguments we have made.

Mr. George L. Roby, of Albion, Mich., read a paper on

"STEEL CORES,"

Which is as follows.

The formation of smooth and approximately accurate holes in iron or brass castings always involves trouble and expense. The method proposed is to substitute when possible a little extra at-



tention and labor in the foundry for the wear of machine tools, supplies, power and labor of the machine shop. Broadly speaking, the improvement suggested is to insert steel cores of the shape and size of the shaft or bar which the hole is to fit in the mold and afterwards remove them from the casting. This has been done in many foundries for years. But, except for special work, the objections of having to make tapering cores so that they may

be removable and that the crystallization and chilling of the iron makes it difficult if not impossible to do any further work on a casting that cannot be brought to the emery wheel, have prevented the general use of steel cores.

It will be admitted, however, that if these steel cores can be coated with a composition which will resist the heat and pressure of the melted iron, be non-conductive enough to prevent "chilling," so free from gas producing substances as to reduce the liability of "blowing" to a minimum, of a nature not antagonistic



Fig. 6

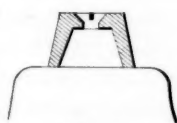


Fig. 7

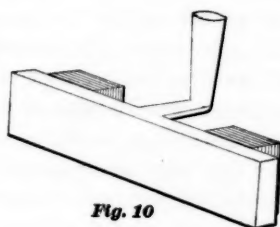


Fig. 10

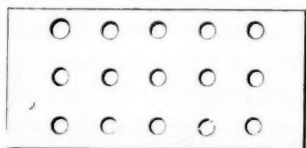


Fig. 8

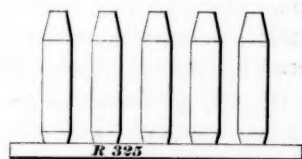


Fig. 9

to the iron, and to which it will lay hard enough when placed upon the steel cores to bear ordinary handling, and yet after the casting has been made, to become so soft as to suffer no resistance to its removal, the use of steel cores is capable of a greater adaptation to modern foundry work than it has yet been given. It is not asserted that a steel core will work in all places. It cannot compete with a sand core for producing a hole that is good enough as made with the sand core without drilling or reaming.

It has been found impracticable to cast a thin shell around a large steel core, but a thinner shell can be cast around a steel core standing on end than lying down in the mold. A thinner shell can be cast around a well proportioned pattern that can be poured slowly than about one having thin webs.

To be on the safe side, it is best to assume that if the core is standing on end it will not give any trouble if the outside diameter is at least equal to twice the diameter of the core. If lying down, the core ought not to exceed one-third of the total diameter of the adjacent part of the casting. Like all rules, these can be broken with impunity if proper precautions are taken, and we know we are beyond the danger line. If the pattern can be gated so a considerable amount of metal may pass through the part having the steel core set, or if enough of the pattern projects above, so that the pressure of the iron will hold it up, much more difficult results may easily be achieved.

In a case where it was desired to cast a finished hole in a very light wheel 7 inches in diameter that was gated to the rim, a large percentage of the hubs were defective at the upper end. The wheel then gated as shown in Fig. 1 gave no further trouble, although the hub was less than $\frac{3}{4}$ of an inch diameter and had a $\frac{1}{2}$ -inch hole, 2 inches long. These wheels went from the trimming room directly to the electing shop. The usual cost in the machine shop being entirely saved, and better fitting journals secured than when drilled in jigs. Another case of finished work in this way was in making the castings for the frame of a small machine shown in Fig. 2. The two sides were joined so that if not set exactly right in the jigs the two sets of holes did not coincide. The shaft working in the bearings A and B were $\frac{1}{2}$ inch and the bosses not $\frac{3}{4}$ inch at the end, the plates being about 1-8 inch thick. Prints were put in and steel cores used. No trouble was had in casting them and a more satisfactory job was done than when drilled, but extra care had to be taken to see that the flask pins were a tight fit, and sometimes a long, straight reamer was run through to line up the holes, but the iron not being chilled gave no more trouble than when drilled.

In Fig. 3 is shown a place where a sand core had been used. Great difficulty was found in getting the holes a satisfactory fit for the purpose desired. The steel cores were cut from the stock used. A perfectly finished hole was obtained at a less expense than with sand cores.

One of the greatest chances for money saving is casting gears, or pulleys that are afterwards to be turned up, the chucking and boring being dispensed with. The castings, direct from the foundry, can be driven on their mandrels and turned up. With care used to keep the mixture at the proper consistency, the fit on the shaft will be as perfect as can be obtained. Irregular shaped holes, or cavities with smooth square bottom can be made with steel cores that can hardly be produced in any other way. Then again, on some light work too small to use sand cores at all, the steel core can be used to great advantage and very small holes can be made. Taking cast butts, for instance, the holes for the pin can be cast in more cheaply and perfectly than they can be drilled even with automatic machinery. Set screen holes can be cored in, and having no sand in the holes the tap will last almost as long as drilled holes. Nuts for coarse threads can be made by placing a section of the screw in the mold, and every wide-awake superintendent who is not more firmly wedded to tradition than to the success and profit of his business will find many similar places for the saving of time and expense.

When lying horizontal in the flask the cores are, of course, only pieces of the stock that is expected to fit the hole cut in the lathe or shaper with clean square ends; but when standing, the usual taper for cope to close over is essential. It is also suggested that the distance from A to B in Fig. 4 should be a trifle longer than the distance through the casting, so that there will be no danger of "capping over." If steel cores properly coated do not come out easily, it is when there is no chance for this reason. Note Fig. 5. On old patterns having small prints it is found convenient to make the core like Fig. 6 and do satisfactory work for small runs, but it will usually be found to pay better to add enough to the print as in Fig. 7.

In doing jobbing work where but a few pieces are made, it is often much quicker and cheaper to make steel cores than to make a core box and sand cores, even when the latter would answer.

Heavy or larger cores ought to have a hole drilled in the end for handling when dipping. The composition should be kept in tightly closed vessels when not in use, as the liquid is very volatile. A small pail with a tight cover will answer nicely. It should be deep enough to take the largest core, and only about five or six inches in diameter to let the hands in the top when dipping small pieces. Drying board should be provided for cores used in any quantity, and as they are dipped, set in the holes. See Figs. 8 and 9. The board should then be delivered to the molder, and it should be made a part of his duty to see that they are taken from the castings and returned to the core room. The board, if neatly made and with a familiar number of holes, makes a good check for preventing the loss of cores, and a convenient way to store in shelves when not in use. If the number or name of the casting is placed on the edge of the board, it will add a still further convenience.

It must be remembered that a great deal depends upon the care with which the core is coated, and this should be entrusted to some employe who not only has an interest in the work, but a chance to see the results. If in proper condition the cores will drain off instantly, leaving a smooth black coat about 1-100 of an inch thick, without any runs or streaks. This will leave the hole approximately 1-100 of an inch larger than the steel core, varying somewhat on account of the size and shrinkage.

The composition is supplied by the S. Obermeyer Co., Cincinnati, O., and Chicago, in two grades already prepared, designated as A and B. The A grade is made for general work, light to medium; the B more especially for heavy castings, which, remaining liquid for some time after pouring, will burn off the A grade too much and make too tight a fit. If the A grade is used for heavy work on extra occasions, it should be used thicker than under normal conditions. There is no other way than by dipping that a satisfactory coating can be put on, and it is not advisable to try to dip the second time without cleaning off smooth-

ly. The composition is a mixture of the most refractory and non-conducting substances known, which are held in suspension by specially manufactured medium which is completely evaporated by the heat of the iron before they come into actual contact. Its non-conductive qualities are surprising. It would hardly seem reasonable to suppose that a coating of .01 of an inch thick would prevent the usual "chilling" of the iron. But how effective it is can be proven by placing two chills of equal size against a light bar, as shown in Fig. 10, one being coated with the composition and the other not. The gate should be placed between the two for absolute fairness.

Like all good things, it is best to use steel cores with moderation. They will not do everything; they must be treated with consideration and coaxed, if need be. The experience every foundryman has had trying to cast around wrought iron will be applicable to their use with all differences in favor of the coated cores. In the hands of a foundryman willing to put up with a few unexpected results and to cultivate their good side they become very effective labor and cost reducers.

This paper was followed by an informal discussion.

It was moved and seconded that a vote of thanks be extended to Messrs. Wickhorst and Roby for their very valuable and interesting papers. The motion was carried unanimously.

PROCEEDINGS OF THE NEW ENGLAND FOUNDRYMEN'S ASSOCIATION.

The regular meeting of the New England Foundrymen's Association was held at the United States Hotel, Boston, March 10, 1897.

After the regular business had been transacted, Vice-President W. O. Barbour read by request the paper read by him at the last meeting, which was on the following topic, "What methods should be pursued to further the interests of this association, and to make it a source of definite profit and pleasure to its members?" W. W. Bird, of the Broadway Iron Foundry, Cambridgeport, Mass., then furnished an interesting paper, as an answer to the questions:

To obtain the best results in melting iron, what should be the percentage of tuyere area of the furnace? What is the proper pressure to the blast, and what are the effects of too little or too much tuyere area or blast pressure?

In reading the numerous circulars with regard to patent furnaces, center blast, etc., one is apt to be confused with regard to what it is possible to do in the line of melting iron and to think that something must be wrong either in one's methods or else in the other party's claims. Therefore before taking up the discussion of this topic it will be well to first consider the theoretical possibilities, as the best results certainly cannot be better than these.

The efficiency of melting like the efficiency of a boiler depends largely on the condition of waste gases; for aside from radiation, the only loss of heat after furnace reaches normal temperature is in what goes off in this way. The cause of this loss may be divided into three parts: (1) Incomplete combustion or carbonic oxide in gases. (2) Excessive temperature of gases. (3) Too much air.

The following table shows the number of pounds of iron possible to melt with one pound of ordinary coke under the various conditions indicated. In making out this table no account is

taken of the heat required to raise the temperature of the brick work or of the heat lost by radiation and conduction, nor of heat supplied by kindling wood in bed. As these quantities would be about the same, the relative values would remain practically the same if these quantities had been considered.

The calculations are based on the following data. The temperature of iron is taken at 50 degrees at beginning, 2600 degrees at melting point and 2900 degrees as it leaves furnace. The specific heat of iron .13 latent heat 233 heat units. This gives 603.5 as number of heat units required to raise the temperature of one pound of common cast iron from 50 degrees to point of fusion and then 300 degrees higher after melting it. Experiments have shown that iron which would be considered fairly hot is at a temperature of about 2900 degrees as it is run into a ladle. The number of heat units per pound of coke is taken at 13,000; the temperature of air 50 degrees and specific heat .237 and 12 pounds as necessary for the combustion of one pound of coke; the specific heat of coke .21.

POUNDS OF IRON PER POUND OF COKE.

Temperature of Gases at-Door	400°	800°	1200°	1600°	2000°	2400°	
Complete Combustion.....	19.8	17.8	15.8	13.8	11.8	9.8	
Percentage of Coke or Carbonic Oxide.	10	18.4	16.5	14.6	12.7	10.8	8.9
	20	17	15.2	13.4	11.6	9.8	8
	30	15.6	13.9	12.2	10.5	8.1	7.1
	40	14.2	12.6	11	9.4	7.8	6.2
Percentage Air Excess.	51	9.7	17.6	15.5	13.4	11.3	9.3
	10	19.6	17.4	15.2	13	10.8	8.6
	15	19.5	17.2	14.9	12.6	10.3	8
	20	19.4	17	14.6	12.2	9.8	7.4

It will be seen from this table that the ratio of melting decreases at the rate of 1 pound per 200 degrees increase in temperature of gases with complete combustion; that the ratio decreases more rapidly the greater the excess of air, while with incomplete combustion or lack of air the ratio decreases less rapidly the greater the percentage of carbonic oxide; that better results are obtained by having too much air than by not having enough, but that this

difference is less as the temperature of the gases increases, remembering that 10 per cent C O is the same as 5 per cent lack of air; that the best results, whether with too little, too much or just the right amount of air, are obtained with the lower temperature.

The best results are to be obtainable, therefore, by having air enough and getting low temperatures at charging door, and is accomplished to a certain extent by having the door as high as possible, so that the gases in passing up from melting point will have a chance to heat up the subsequent charges before escaping. There is generally a loss, however, by the hot gases passing through the fuel of next charge and giving oxygen to the fuel carbon to form carbonic oxide which will burn later when it gets air.

After the charges are all in the temperatures of the gases increase as the last charge settles, while in the first of heat a considerable amount of heat is required to warm up the furnace itself, relatively greater the smaller the furnace, so the last results are probably obtained in the middle of heat.

Taking the ratio for ordinary practice in melting as 8, the amount of air required is $1\frac{1}{2}$ pounds per pound of iron or 16 to 18; a foot of air must be put in for each pound of iron.

Let Q be the number of cubic feet of air required, then Q equals $A V T$ —where A is "area" of opening, V the "velocity" of flow and T the "time." The relation between T and Q depends on rate of melting, so that the necessary amount can be obtained by making area larger or smaller, according to charge in velocity, which depends on pressure. Assuming the rate of melting, which must necessarily be limited by area of furnace, the amount of air needed can be found.

The real resistance to the flow of air is in the furnace opposite tuyeres rather than in the tuyeres themselves, as is shown by the blast gauge, which will vary during the heat due to the settling of bed while the revolutions of blower and tuyere openings remain the same, also in difference of blast between coke and coal.

It is desirable to carry pressure enough to get the air into center of furnace and well distributed through the fuel. Too much blast will carry fire higher and consequently give hotter escape

gases, beside burning out the lining more rapidly. But it must be remembered that while the blast gauge may show 8 or 10 oz. of pressure, it does not follow that the air is going in—that is, with a centrifugal blower—however much the flow of air is decreased, so that it is well to know the pressure with all the tuyeres closed and then open them, so that the pressure is a little less. It is then certain that the air is going in to the capacity of blower.

An 8 oz. pressure seems to be sufficient for furnaces under 4 feet in diameter, with increase of pressure for larger sizes. The ratio between tuyere and furnace ranges from 1 to 4 to 1 to 20 in the various furnaces in use. The larger the tuyere area the more air up to the point where flow of air is limited by fuel in cross section of furnace itself, and consequently the more rapid the melting; but different furnaces, having same ratio and blast, will not give same results, as no two melters will have same iron and fuel nor put it in the same way, so that the same pressure outside may give more or less in one case than in the other. Too rapid melting is apt to give slacker iron, but this of course can be changed by varying charges.

The conclusion is that furnaces melting 8 to 10 must have about the right proportions for method of charging used, that those requiring fuel 6 to 1 need looking after, and that those claiming 15 to 20 to 1 need watching.

PROCEEDINGS OF THE PITTSBURG FOUNDRYMEN'S ASSOCIATION.

The meeting held by this association March 22 was a representative gathering of the most prominent foundrymen of Western Pennsylvania. It was presided over by the president, Robert Taylor.

Following the transaction of routine business President Taylor welcomed the visiting foundrymen, explaining the purpose of the association, and inviting all to active membership. The regular program being taken up, John A. Penton, Secretary of the American Foundrymen's Association, read the following paper.

THE NEED OF A BETTER ORGANIZATION AMONG FOUNDRYMEN.

Writers and speakers are fond of referring to this as an age of organization and concentration. The assertion is true, but the implication is false. All the ages of civilization have been ages of organization and this differs from its predecessors only in the fact that steam and electricity have enlarged the geographical limits of unity, making possible to the people of a state a closer association than, in other times, was given to those of a city, and to those of a nation a degree of unity not attainable by the inhabitants of a province without the aid of these agencies. Organization has enlarged its scope, but it has not changed its nature, its objects or its potentialities. Civilization itself is organized intelligence, and every progressive instinct in the race finds its expression in some new combination for the attainment of mutually desired ends.

The time-defying pyramids of Egypt stand as a monument to the effectiveness of concentrated effort, offering testimony to what may be accomplished by the combined and properly directed energies of thousands, turned to the accomplishment of one given object. The land of the pyramids furnished too another lesson of similar import. It was there that the brickmakers combined and won the first strike recorded in history when their masters took from them the straw necessary to their business, and still required the same output.

Coming down, in our search for striking precedents, to times much nearer our own, we may point to none whose results have been more far-reaching or more prolific of lasting good than those of the ancient London guilds, which played so large a part in events which gave the first impetus to the spirit of British trade. From their inception, they wielded an immense influence in shaping the history of their country, which may almost be said to be the later history of trade, so closely is it interwoven with every movement in the development of modern commerce. These guilds were nothing more than associations of the representatives of the different trades, and it is more as the result of their consolidated experience than from any other cause that British manufacturing establishments and British products began at an early date to invade the markets of the world, and laid the foundation of a foreign trade that still withstands the combined onslaughts of the other nations of the globe.

It is to these, and to the larger organizations that have succeeded and supplanted them, that Great Britain owes the commercial supremacy she enjoys to-day. One need go no farther in search for proof of this than his newspaper will carry him, to discover how sensitively responsive is the British parliament to the sentiment of British Chambers of Commerce and British Boards of Trade. Administrations at Westminster always have their ears to the ground to catch the first indication of what the great commercial bodies regard as necessary in the way of legislation to aid the foreign trade, while it is no less solicitous to learn the wishes of the huge labor combines as to conditions at home. No man can be so blind as to believe that cabinets and parliaments would be so attentive to individual voices or so unreasonable as to imagine that similar results might have been attained without complete and thorough organization. It is to the representatives of large bodies, acting in harmony, that lawmakers listen, and it is organized effort, too, that secures advantages outside the realm of legislation.

It may seem to some that I wander from my theme, but, my friends, thousands of tons of foreign-made castings are coming annually from across the ocean to our sister republics in South

America. They come in mining, milling and machine shop supplies, in agricultural implements and in other forms in which the American foundryman yields precedence to no competitor, and if we ship to one of these countries anything, from a brake-shoe to a Corliss engine, it goes by way of Liverpool, because the organization of English merchants and manufacturers have forced the encouragement of foreign shipping, even to the extent of heavy government subsidies to transoceanic lines.

And this brings us down to the needs of the foundrymen. The necessity for closer association and the mutual helpfulness of trade organizations must be conceded by every man with sufficient intelligence to note the course that is followed wherever men have risen above a semi-barbaric state. Both for the accomplishment of specific purposes and for the general improvement and education of their members, trade organizations have a value well-nigh inestimable. There is only one man to whom such organizations are not necessary, and he is the man who knows it all. There may be an unusual number of such fortunate persons among foundrymen—men who have nothing to learn and fear that some of the valuable and exclusive information they possess might be absorbed by their rivals if they attended such gatherings as this. But it is a very wise man who can learn nothing from his competitors, and even that man who has the feeling referred to might stumble upon some unaccustomed and valuable idea through associating with his fellows. He would consider it a reflection upon his business ability to intimate that they could not get value received in commercial dealings, and can hardly be said to compliment himself in fearing that he might not do as well in such interchanges of ideas and experiences as these gatherings foster and encourage.

The only reasonable theory upon which the lack of close organization among foundrymen in the past may be accounted for is that the fierceness of competition has bred distrust and suspicion. But that very competition breeds also a new unity of interest. It is through such associations as this that the roughest corners are to be smoothed away. As men engaged in similar lines of industry mingle together they discover that it is "the trade"—the

man who buys their goods—that is knocking their heads together and urging them on to profitless conflicts, and means for overcoming some of the difficulties which confront the individual are laid open to the mass. Not only will an association benefit its members along the lines suggested, but a moral obligation to protect them in certain ways also exists.

I have more faith in associations of men whose lives are spent in similar lines of activity to secure by unity of effort prosperity for themselves, for their employes and for the country than I have in all the combinations of politicians whose horizon is bounded by party advantage on the one hand and pocketbooks on the other. If this great country of ours, whose marvelous resources we never tire of proclaiming, and whose rapid progress has been due, thus far, more to those resources than to all other causes is ever to take the place destiny designed for it, the foundation for such material prosperity must be laid right here!

To this and similar organizations in other lines must we look for the planting of the seed that shall grow into a widespread sympathy, a universal co-operation and a more general understanding of what is needed to prevent our industries from falling into periods of depression as that from which they seem to be just now slowly emerging. If we can get men to give a portion of their time to considering together the best methods of overcoming this or that obstacle that presents itself to each—how best to estimate the cost of castings, how to avoid trouble with workmen, how to reach new markets—we will be doing a grand work, a work in which each must receive benefit from his fellow and give something in return. The meetings at stated intervals, the quiet talks over foundry problems, the discovery of remedies for evils we have been unable to correct alone, and the inevitable growth of mutual confidence and respect that follows all this—these are the results which make organization imperative at a time when all those with whom we have to deal are banded together in one way or another as the peculiarities of their pursuits seem to dictate.

Prominent foundrymen have lived and carried on business in the same city for years, only to meet and become acquainted for

the first time at such gatherings as this, and have been surprised each to discover that the other had neither horns nor hoofs. Through such meetings they have found ways of mutual helpfulness, and have accomplished the saving of energies hitherto expended in purely gratuitous exercise of fighting each other through sheer prejudice.

If we go still further and point and take part in the deliberations of the national body in this or any other line we only widen by that much our sphere of usefulness to ourselves and our associates. Local and state bodies are properly the feeders to the wider organizations, and, while they serve well in their own fields, it is to the greater associations that we must look in critical periods and when trade emergencies arise. We meet men of note in the business and make a part of their exceptional experience. The man who could find no benefit from such meetings would not be improved by any earthly agency. I know personally several men who have declared themselves well repaid in dollars and cents for the time and money invested—and I use the word invested advisedly—in attendance upon the meetings of the National Foundrymen's Association in Philadelphia last May, while the pleasure and intellectual profit of the event stand as extra profits. I have in mind one well-known foundryman who saw there an original appliance which filled a long-felt want in his establishment, and who immediately adopted a modification of it fitted to his peculiar needs, thereby effecting a saving and an improvement in work which he had long contemplated vainly.

Still one step farther and we arrive at the national association of manufacturers, which is but a logical sequence of the local organization, and whose benefits supplement those of the latter.

It is now only a few years since the first great foundrymen's association in America grew out of a preliminary meeting at which less than half a dozen men were present and already—through the interchange of ideas and the spread of information—more good has come to the business than in all the previous history of founding in this country. Nor has the benefit been confined to this continent. The papers read and the discussions car-

ried on have been published in many languages in the trade journals of other countries, while we in turn have profited by similar movements abroad. There were skeptics at first. There may be some still. There are always men who are slow to accept any new idea, but sooner or later they must acknowledge the value of the work that has been done and in the end be compelled, like those who persecuted Galileo for declaring that the world was round, to acknowledge their error. It is certain that only those who have tried the experiment of organization, who have associated themselves with their fellows and felt the benefits of such association are competent to pass judgment.

This idea has grown and spread and will continue to do so. There are now several bodies in various sections of the country meeting and working as you are, with the same inspiration, the same aims and the same incentives. Their influence is being felt in every foundry in the land and must continue to be a growing power.

Those who fearlessly take the initiative in such matters, sometimes get less credit than they deserve when success has crowned their efforts. As in the parable of the workers in the vineyard, those who come in at the eleventh hour get as large a wage as those who toiled through the heat of the day, but to the wages of the latter are added a personal satisfaction and a consciousness of duty well done, which are full compensation for their extra toil.

If business men and manufacturers in general and foundrymen in particular could be persuaded to see where their true interests lie and to seize every opportunity that presents itself to co-operate willingly and heartily for the common good they would be able to exert an influence of inestimable value.

Surely no more laudable or patriotic work could enlist our sympathies than to place our business on a basis ensuring steady and remunerative labor to the toiler and reliable work to the consumer, and none could redound with greater glory to our country and its welfare.

Mr. William Bradbury, of the Anshutz-Bradbury Co., who is one of the oldest foundrymen in Pittsburg, and who was closely

identified with the earliest organization established by the molders of America, followed in a reminiscent strain, telling of the difference between the shops of to-day and those of his boyhood, his connection with foundries reaching back nearly half a century. In speaking of the advancement which had been made, Mr. Bradbury noted what appeared among the possibilities of the future. He recommended a free interchange of ideas as doing more toward a general improvement of the trade than anything else.

Thos. D. West, of the T. D. West Foundry Co., Sharpsburg, Pa., was a central figure, and constantly surrounded by his many admirers. In a neat speech he told of the benefit the organization had already conferred upon its members, and urged the necessity for a closer relation between manufacturers engaged in the same trade.

A REVIEW OF THE FOUNDRY LITERATURE OF THE MONTH.

THE FOUNDRY.

W. L. Hayden, in his second contribution on the subject of "Down Draft Core Ovens," writes of the underground plan, showing how a saving in fuel may be effected by this method and what is more important, a uniform temperature may be maintained. All foundries know of the trouble caused by imperfect circulation, when cores are burnt in one part of the oven while others remain practically unchanged. With more attention paid to the construction of core ovens, there can be no doubt but that we shall be able to utilize more of the heat, and to distribute it in such a manner as to dry the cores uniformly.

Those who believe that all that is needed to produce better molders is an apprenticeship system compelling them to serve a certain length of time, may find in an article on "Making Molders," contributed by Herbert M. Ramp, other reasons for the present condition of our mechanics. Mr. Ramp contends that our foundrymen are using the best man in the best place, and that while this rule is based on common sense and economy in business, still it deprives the molder from the chance of obtaining an insight into all the branches of the trade, as he could formerly, when his productive capacity was not taxed to the extent, which it is now.

In order that the reader may form an opinion of Mr. Ramp's ideas on this matter we attach the following abstracts from the article:

A few rules, a combination of employers, a small financial bonus, will not change the trend of a man's disposition; it may slightly alter or improve it, but it will never go deep enough to alter the man or boy's nature, be he slothful, negligent or careless. The boy that comes into the foundry, rough and uneducated, may succeed; the college graduate may succeed, but neither will do so through want of or superior education; it is

the practical ability, the energy, the judgment with which they attack their surroundings, that by adoption becomes part of their life and expectations. * * * Every boy or man has his own individuality, and when you hedge about it conditions, you are destroying his originality, and teaching him to depend on other people's brains, when you specify what length of time he shall serve in one branch or the other of the business, every boy is placed on a level, the bright, active mind, the one with dulled, blunt perceptions; when it is stated the apprentice shall receive a certain amount each year, all served alike, it is cold blanketing the aspirations of the rising and energetic mechanic, and when such measures are adopted to improve the quality of our mechanics, it appears absurd. You cannot make good mechanics of all, or of one-half the apprentices we teach, yet the proposition is to treat all alike, our most promising and our most hopeless. This is not a question of making better molders, it is a question of procuring better men in the foundry, better boys, and that done, the molders make themselves. * * * Pay an apprentice what he is worth, if it is one dollar per day or two; make him feel that merit is ever recognized, and always hold before him the possibility of advancement. Never permit him to feel he has reached the highest point he can hope to attain, or restrict him to a certain number of years upon this or that kind of work. Many a good apprentice has acquired "don't care" habits simply by the environments placed around him. It is far easier to destroy ambition in the young than to inspire it into those who possess none. If you go into the market to purchase an article you expect to pay for it according to quality, why should you not pay for service in the same manner? You place a boy of inferior, and one of superior, talents side by side in the shop; you expect to pay both the same and have both serve the same length of time, and at the end of their apprenticeship pay the better one possibly twenty-five cents a day more. How little encouragement there is in that for the ambitious, the aspiring mind. The truth is we do not pay good molders enough, and often pay poor ones too much, in comparison, and who desires to put superior ability, when they possess it, on the level with the most inferior

in their life's business? * * * We also hear the oft quoted assertion: "We have not as many good molders as we did some years ago;" that the good mechanic is more rare, and not often found in our foundries to-day; that the business from a scientific standpoint is deteriorating as regards quality, and other nonsense of the same import. But this is not true. There are just as many good workmen in our country to-day as there were thirty years ago, and more, because of the increased education of the people and the development of ability, for the American people are better able to take care of themselves or excel in any pursuit to-day than ever in the history of the past. But other reasons have brought up this strange, but not unfamiliar or unexpected, cry of depreciated ability.

The molder of to-day, as before stated, is more of a specialist, he is taught more nearly one branch of the business, and becomes an expert in that. Constant experience and practice make him an adept in his line, but when you remove him from it 'tis not to be expected he will equal an expert in some other line. In this capacity he is more valuable to his employer and more safe from competition among his fellows. Some shops carry this system so far that a man may work for years on one job. It has become by continued association easy and profitable labor to him and brings a good return to his employer, and when he drops out and the vacancy is filled by a new man foreign to the job, compared to his possibly departed predecessor, the firm finds he cannot perform as good or rapid work, they send up a howl of terror that molders have fallen from the pedestal of science and are rapidly descending to the level of a ditch digger. Too often they do not consider competition has driven mechanics to specialize their efforts, the same as manufacturers specialize their business, and foremen specialize their men, by reserving or changing work so that the best adapted man will procure the work he is suited for. * * * Furthermore it is true that the quality of work to-day is superior to any ever produced in this country; the very fact of specialties in all lines has perfected our methods of work and drilled our men to keener preceptions of what each individual casting required. * * * The natural in-

clination among our founders is to use the best man in the best place. This rule is based on common sense and economy in business, and also to use an apprentice where he would return the greatest profit. This may not be altogether the intention of the employers, but in nineteen foundries out of twenty it is actual practice. No one can dictate or say it is wrong, for it is often necessary in business. But better general mechanics will not be made by confining them to specialties, or better molders produced until better men are induced to enter the business.

G. D. Rice shows several examples of sand-sifting machinery, calculated to aid the founder in selecting what is most suitable to his wants.

V. L. Wolfe has a paper on "Controlling Iron Mixtures" in which he calls attention to the necessity of conducting physical tests of the product, even though it be made from materials, the chemical analysis of which is known. He concludes as follows:

As an illustration of the value of having a good testing machine around, I will conclude this article with a truthful tale. Recently a well-known firm had three car loads of pig iron shipped to them. The quality of the iron was a matter of dispute. The foreman of the foundry was instructed to use only 1,000 pounds in a total of fifteen tons. The result was disastrous. Three hundred pounds was knocked off the strength of every bar cast. Succeeding tests showed no improvement. Then two car loads were sent back and what was claimed to be a better grade was returned in its stead. Same old story. Then the old mixture was resumed and the condemned iron was allowed to lay.

The foreman was a believer in the idea of patronizing home industries. Most of the iron being used by his employers came from the greatest country on earth, the despised brand didn't. One day, after the matter had quieted down and the powers that be had turned their attention to more important subjects than looking over test reports, by arrangement with the superintendent 1,000 pounds of the condemned iron was put in with an increased amount of another brand as a conquerer. The other

brand was also a home product. Inside of a week there was being used over 6,000 pounds of each of the home articles, with the satisfaction of seeing each bar stand a test of over 2,500 pounds, which is the standard.

"Phenomena of Cast Iron Investigated," is a continuation of a series of articles upon "Cast Iron," by S. S. Knight. The author explains how many of the so-called phenomenon may be accounted for, and presents to the student of metallurgy one of the most complete chapters that has appeared on the subject. We are, owing to lack of space, unable to reproduce or review this paper in the way it deserves, as the article cannot be separated without detracting from its force, and must therefore refer those of our readers interested in the subject to the paper itself.

W. J. Keep, in "Cast Iron Notes," gives the following interesting information in regard to molding sand:

* * * A molding sand should be composed of about ninety parts of silica sand, and about six parts of alumina, to bind the particles of sand together. The silica is very refractory and cannot be melted by the iron, but without a binder it would not make a mold of sufficient strength to contain the melted iron. Alumina is the best binder, and there should be in the sand just enough to give strength to the mold. More than this will decrease the refractoriness of the mold. Magnesia is a good binder and is refractory, but it lessens porosity and is therefore an undesirable element. Porosity is very essential in a mold. The sand must be somewhat moist, and the evaporation of this moisture into steam, together with the air in the mold, and the gas formed by the burning of bits of roots and sticks in the sand, and the gas which forms from metallic oxides which are always present, must be able to escape as fast as the mold fills with iron. It is better for these gases to escape through the walls of the mold than to provide an opening for escape. Iron will lie against the walls of the mold better if the sand is open enough to allow the gases to pass away from the iron as it fills the mold. To cause the gases to take a course away from the iron, not only must the

sand be open, but passages for escape are made nearly to the wall of the mold with a vent wire, and sometimes loose material, such as broken coke, is placed in the sand to allow the gas to escape through the more open grain.

Lime is a very undesirable element in molding sand, but some is always present. Lime, silica and alumina form together a fusible slag, though neither can be melted alone. Silica and alumina in a good molding sand are necessities, but if lime is present at the same time a portion of each will melt and adhere to the surface of the casting as a hard skin or scale. The hotter the iron the more will burn on. This is the origin of scale on castings. Mica is very refractory, and some of the best molding sands contain small glistening particles of mica.

It is not the finest grained sand that will make the smoothest casting. The sand must have sufficient vent to allow the iron to lie against the wall of the mold, and be refractory enough not to burn into the surface of the casting. If burned sand is removed, the imprint of each grain will show on the surface. Hard ramming in any one place may prevent the iron from lying close to the sand, and thus cause the casting to have an uneven surface.

The bank from which molding sand is taken contains various layers and pockets of different grades; coarse, open sand, suitable for molding heavy machinery, fine sand, suitable for stove-plate, and still finer sand for brass castings. Silica sand without any cementing material is also found in the same bank.

The one in charge of grading and loading separates each grade from the others and ships each founder sand of uniform quality suited to his special requirements. Machinery sand and stove-plate sand are each graded according to coarseness into No. 1 and No. 2; or the numbers may run from No. 1 up, so that fine stove-plate is No. 5. Molding sand is obtained at various points near Albany, at Crescent, and around Waterford, in New York. An analysis of No. 1 stove-plate sand from Crescent showed 80.99 per cent silica, 4.49 per cent alumina, 3.92 per cent oxide of iron, and 0.61 per cent lime. Sand very similar to this, but generally of a coarser and more uneven grain, is found on the southern shore of Lake Erie, near the line between Pennsyl-

vania and Ohio, and a similar sand, but of finer grain than Albany sand, is found at Newport, Ky.

Albany sand has rated as a very superior molding sand for more than half a century. Molding sand can generally be found near each foundry, but if such sand contains too much alumina, an even-grained silica sand, with the grains the same size, can be mixed with the molding sand, so as to bring the proportion between silica and alumina as near 90 and 6 per cent as possible. If the sample sent me, which suggested these remarks, is the best that can be procured in that locality, find a similar silica sand and mix in a little at a time until the right proportion is found. Such artificial sand generally resists the iron fully as well as natural molding sand.

IRON TRADE REVIEW.

B. F. Fells illustrates an apparatus which he has recently completed and used with success in casting aluminum bronze into press rolls for paper mill machinery. The idea is also applicable to the casting of other articles from the same metal.

After describing in detail the operation of the process, Mr. Fells concludes with the following observations:

"The process of manufacture of the aluminum, as perhaps all foundrymen do not know, consists in dissolving alumina in a molten bath composed of the flouride of aluminum and the flouride of some metal or metals more electro-positive than aluminum. An electric current is passed through the molten mass and aluminum is produced by electrolysis of the dissolved alumina. The pure oxide of aluminum is made from the native oxide of the metal in a mineral that is called bauxite. This mineral is found in Georgia and Alabama. The composition of the bauxite best adapted for the manufacture of alumina is as follows: Silica, 3 per cent; titanitic acid, 4 per cent; oxide of iron, 2 per cent; water of hydration, 32 per cent; alumina, 59 per cent. This ore exists in the following forms: 1. In round nodules, or pisolites, some of these being in sizes up to two inches in diameter. 2. An agglomeration of

these nodules into a conglomerate, the binding material between the nodules being pure alumina. 3. A massive formation. 4. A fine powdered condition in the beds at the banks.

"I believe that atmospheric conditions affect the casting process of aluminum at times. The casting room should not be such as to saturate the atmosphere at a low temperature, but steam should be used to prevent this and give the necessary heat to enable the room to carry sufficient moisture and the upper ventilation will prevent the temperature from rising too high. A low studded room will soon either become too hot to get the benefits of the moisture or the atmosphere will become saturated at low temperature. A very high studded room is harder to condition and is most easily affected by outside weather than one of medium height, and while you must not strive to put heat and moisture enough into such a room as to cause saturation or 'dew point,' such a room can be held at a proper temperature and carry a large quantity of moisture. Fans for ventilation prevent the proper conditioning of the air and should be avoided, as should all currents or draughts. Ventilation should be from above and enough of it allowed to keep the atmosphere in the room fresh and healthy."

IRON MOLDERS' JOURNAL.

Thos. A. Haigh writes of, "How and Where to Gate Castings," in which he notes that when there is not room for a skim gate, as sometimes will occur, the only precaution against the entrance of dirt that can be taken is to watch, as in the case of the skim gate, that the gate into the casting is not too heavy for the capacity of the runner sprue, and to place at the top of the latter a good head or basin which, with a quick turn of the ladle will fill up immediately and keep full, so that the slag or dirt will be kept floating on the top surface of the iron and the runner gate fed from the clean iron in the bottom of the basin.

MACHINERY.

George A. Webster has the following on "Foundry Time and Cost Keeping":

Is it practical to know accurately the cost of work? Is it profitable to obtain this result at a moderate expense? These are familiar questions to every foundryman, and they are receiving more consideration as competition becomes sharper.

It is claimed by numerous men connected with the iron business, that a cost system with any degree of reliability is foreign to foundry work. A foundry foreman who is familiar with his business is supposed to be able to give a correct estimate for new work, and it is believed he should find no difficulty in obtaining, by estimate, a correct account of work already completed, thereby saving the expense of a cost system and adding something to the profits. Estimating on foundry work, either new or old, is a very unsatisfactory method of obtaining cost or prices, because of the new difficulties arising from each piece of work, even though it be two castings from one pattern.

By the system which I shall endeavor to outline, it will be seen that it is not only practicable to obtain correct results, but a profitable feature, and the expense, instead of diminishing the profits, enables the foreman, by use of a system, to so arrange his work as to increase them.

One extra clerk is all the office help that is required to keep the time and costs for a foundry employing about three hundred men. It is necessary for him to have an office close by the entrance to the works, and by which the men are to pass in going to and from work. He is also supplied with a check board, upon which hang metal checks numbered from one to three hundred, and with sheets (day-sheets) 12x16 inches ruled into one inch squares, numbered to correspond to the check-board and checks.

Three books are necessary. First, an ordinary pay-roll; second, a casting-book, which contains the weight of all the castings, the mixture and weight of each day's charge, the amount of coal and wood used each day, and the weight of the sprues and pig-bed. All of these being entered under their corresponding heads, the different castings (loam, dry and green sand), and the number of each being kept separate. Third, the cost-book, which is the most important, and which contains entries, under each separate order number, of all the time of the different departments,

coremakers, molders, chippers, helpers and teamsters, as well as the separate weights (under the proper head of loam, dry or green sand) of each casting.

The method of keeping time, which is simple and effective, occupies about one hour a day. Every man, as he passes the time-keeper's office, is handed a check from the board. After the whistle is sounded, a line is drawn across each square on the day sheet corresponding to the number of each check that is not called for, and it signifies that the man whose number is not taken is an absentee. Should he arrive late, he may be credited from the time his check is taken off the board. The checks are deposited as the men leave at the end of the session, and they are taken as they begin another.

As the orders for work arrive they are entered (at the main office) on an ordinary order-book and are given a number. The cost-clerk, each morning, fills out an order blank from this book and makes an entry of it on his cost-book. It is then passed to the man in charge of the pattern room, who, after getting the pattern into shape for the foundry, places a sticker on it containing the order number. The order is then handed to the foreman of the foundry, and the pattern is placed on his platform, who, after having the casting made, hands it to the weigher. After the castings have passed through the casting room and have been cleaned, they are weighed and the weight of each is placed on the back of its respective order. This order is then forwarded to the time-keeper's office, where its number, the number of pieces and the weights, are entered on the casting-book, under their respective heads—loam, dry and green sand. The melter hands to the time-keeper, each morning, the weight of the previous day's charge, the amount of coal and wood, and the weight of the sprues and pig-bed, which are also entered on the casting-book. Thus, the footing of the castings made each day, and the iron melted, should come very near a balance after deducting about 6 or 8 per cent for waste. This constitutes a check against omissions or over weights.

After the molders have finished their work, the time-keeper, with his day-sheets fastened handily to a board, passes to each

man and obtains from him the exact time he has been employed on each mold on his floor, placing it in the square on the day-sheet corresponding to the workman's check number.

The division of time into classes, according to the amount of wages each man receives, makes it necessary to employ some method by which the different classes may be distinguished. It is done by allowing a certain number of squares on the day-sheets for each class, viz: First-class molders, 1 to 75; second-class molders, 76 to 125; third-class molders (apprentices), 126 to 150; molders' helpers, 151 to 225; first-class coremakers, 226 to 250; second-class coremakers, 251 to 265; melters, 266 to 268; melters' helpers, 269 to 275; yard hands, engineers, carpenters, gatemen, watchman and other extras, 276 to 300. The next duty of the clerk is to enter the time he has taken on the day-sheets into the cost-book, under the different classes of labor and the different grades of work. He also transfers from the casting-book the weights, denomination, and number of pieces of castings on each different order number, keeping the time employed in preparation under its separate head, because when the cost is figured, all preparation labor is figured at actual wages, while the direct cost is figured at average wages, and has a percentage on each separate order, the matter of figuring a cost is reduced to its simplest form.

To establish a permanent rate of wages by which to figure, the average of the different classes is found, and to it is added a percentage for profit. Ten first-class molders (those receiving \$2.50 per day and over), range from \$2.50 to \$3.00—the average being \$2.75, to this add 20 per cent, which gives for first-class molders' wages \$3.25. On the casting-book the cost of each day's melt is carried out, and the percentage of waste determined. It will be found that this percentage will vary perceptibly in accordance with the different mixtures.

The foreman of the core-room keeps a record of the core-sand used on each job, and it is figured in the cost at a given price for the different mixtures.

There are numerous other small details which arrive daily, but a clerk with a little experience in the foundry business can easily

dispose of them, and so arrange matters as to facilitate the workings of the system.

Non-producing labor is always more or less necessary about a shop. This is taken into consideration by having all the time of such men charged to a letter. It is thus separate and the percentage is added to each order, thereby making each bear its proportional share of the expense of running the shop.

After completing an order, a cost-slip is made out and handed to the main office, which may read something like the following. The order as it arrives, is:

"Make four castings from the patterns sent.

JOHN JONES, Boston."

THE SLIP.

Order No. 100. Name—John Jones.

Make 4 castings to his patterns.

PREPARATION LABOR.

1st class molding.....	2 hrs. at 30c =	\$.60	
Helpers.....	6 " 15c =	.60	
Carpenters.....	1 " 22½c =	.23	
Team.....	1 " 35c =	.35	
1,500 lbs. iron at 1¼ + 6 p. c.....		19.88	
			\$21.96
1st class molders.....	20 hrs. at 32½c	6.50	
2nd ".....	20 " 25c	5.00	
Molders' helpers.....	20 " 17c	3.40	
1st class core-makers.....	14 " 28c	3.92	
2nd ".....	8 " 23c	1.84	
Chippers.....	12 " 18c	2.19	
Carpenter (boxing).....	2 " 23c	.46	
Teaming.....	1 " 70c	.70	
Lumber (crating).....		.70	
100 brick at \$4.00 per M.....		.40	
2 lbs. nails at 7c.....		.14	
1 bbl. core sand at 14c.....		.14	
6,500 lbs. iron at 1¼c. + 6 p.c.....		86.13	
			\$ 133.45
Add 25 p.c. for expense.....		33.36	
(Cost, \$0.23 lb.) Cr. By iron flask 1,500 at 1½.....		16.88	
			\$149.93

From this system monthly reports may be made out, showing the actual cost of the month's work, the actual receipts, the profit or loss on each separate order, and the profit or loss for the month or year. It has been applied with equally good results to factories operating iron foundry, brass foundry, pattern shop, machine shop, steel shop, forge shop and boiler shop, and it can be so modified as to be very successful in yacht and ship-building yards.

THE RAILWAY AGE

The plant of the American Steel Foundry Company, located at Granite City, Ill., is described in the issue of March 5th.

THE TRADESMAN.

There is much that is true in a short sketch, headed "Spread the Light," from the pen of E. H. Putnam, in which he says:

"I suppose that the trade journals are read almost exclusively by employers and their foremen. This is greatly to be deplored on every account. No manufacturer will deny the benefits he derives from this reading; and if all the mechanics in the factory would read the current literature pertaining to their trades the benefits to industrial society would be thus immensely augmented. I believe the time is not far distant when no respectable mechanic will be ignorant of the literature of his trade.

"One prime reason for the apparent apathy in this matter is the fact that the majority of the mechanics are ignorant of the fact that such literature is easily procurable. I well remember the first book on founding that I ever read—Dr. Kirk's well-known work—and with what industry and zest I explored its helpful pages! Years passed by, and accidentally my attention was drawn to a journal that published articles on molding and founding generally. This journal advertised books on founding. Now, I own the books, and I read each number of the journal.

"Now, how do you suppose I first got hold of the book? My employer told me that he had a book on iron founding and that he would lend it to me if I wished. That's the way I got the first book. And how did I first discover the journal? My employer

one day told me that he had just found the thing he had been looking for—a journal that treated all about iron founding. I read his copy for a while and then became a regular subscriber myself.

"Now, why wouldn't it be a good plan for every employer to tell his workmen where and how they can get exactly the kind of reading that will do them the most good. The large employer could most profitably spend some money in getting his men started to reading in the right direction. There are hundreds of mechanics who would jump at the chance to subscribe for a trade journal if they knew just where to find what they want. Their ignorance in this matter is no discredit to them. The sample copies are only sent to the firm, and the firm seldom offers a sight of it to the mechanic.

"Gentlemen, when you see an article that you think would benefit your men, take it into the shop and show it to them and let them read it. Why not? And why not in every way in your power encourage all of your employes to read the current literature of their trades? You will be amply repaid, not only in dollars and cents, but also in the gratitude of the men whom you have helped to rise a little higher."

The same author, answering an inquiry for something superior to beeswax for finishing patterns, so that they will leave the sand easily, recommends a coating of bayberry wax applied after the manner prescribed below:

Beeswax has always been and is still much used for coating patterns, both to render them smooth and prevent water from adhering. But beeswax is quite soft in warm weather, and is therefore objectionable on the score of being sticky at such time.

But, if you use beeswax, why do you melt it in order to apply? Why don't you shave it up and cut it with benzine? Then apply with a paint brush, when the benzine will quickly evaporate, leaving a coating of wax all over the pattern of perfectly uniform thickness. But do not use beeswax. There is another kind of wax that is readily cut by benzine, but which does not get soft and sticky in the hottest weather. Bayberry wax is the *sine qua*

non of every molder who once uses it. I always keep a bottle of it in the foundry office, and every molder whose pattern does not part from the sand perfectly is free to use it. It produces a very hard, impervious coat, and is very much more lasting than beeswax.

To prepare it for use, take a piece in your hand and run it over a carpenter's plane, producing thin shavings. Put a handful of this in an empty pint bottle and fill to near the neck with benzine. If the shavings have been made sufficiently fine you can use in ten minutes. Or you may whittle closely with a pocket knife, and placing in the bottle with benzine, set in a warm sand heap at night, and the mixture will be in splendid condition for use next morning. I have never read of this preparation, and never knew of but one shop where it was known except where I myself introduced it. I doubt that it is very widely known, and am inclined to think that I ought to buy up all the bayberry wax in sight before publishing this article. It can be found at the drug stores. It is sometimes called tallow instead of wax.

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